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PACIFIC NORTH WEST FOREST AND RANGE EXPERIMENT STATION

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A FIELD GUIDE FOR STAND BASAL AREA, AVERAGE DIAMETER, AND TREE SPACING RELATIONSHIPS

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by

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ABSTRACT

This guide is useful in manipulating forest stand density to silvicultural prescriptions in basal area. Reference equations and graphs are presented in English and metric units. Some examples of application are shown along with examples of other uses.

KEYWORDS: Stand basal area, diameter measurements (stem), stand density measures.

INTRODUCTION

Field foresters and technicians often manipulate forest stand diameter and basal area[1] to a given silvicultural prescription. This guide is a handy pocket reference for making the job easier.

The graph (fig. 1) of basal area in square feet as a function of average stand diameter in inches and trees per acre was developed by solving the following equation (0.005454154 from Husch, Bertram, Charles I. Miller and Thomas W. Beers, 1963. Forest Mensuration, 2nd ed., p. 100. Ronald Press Co., New York.):

$$B = 0.005454154 \times \bar{D}_g^2 \times TPA;$$

where,

$\bar{D}_g$ = diameter of tree of average basal area in stand (inches),

TPA = trees per acre, and

B = basal area of stand (square feet).

The guide describes stands up to 500 ft^2 per acre or 100 m^2 per hectare. Although basal areas this high are rare, they may occur in old-growth stands on high sites.

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[1] The sum of cross-sectional areas of all tree stems 4.5 ft above the ground expressed in square feet or square meters on a given area.

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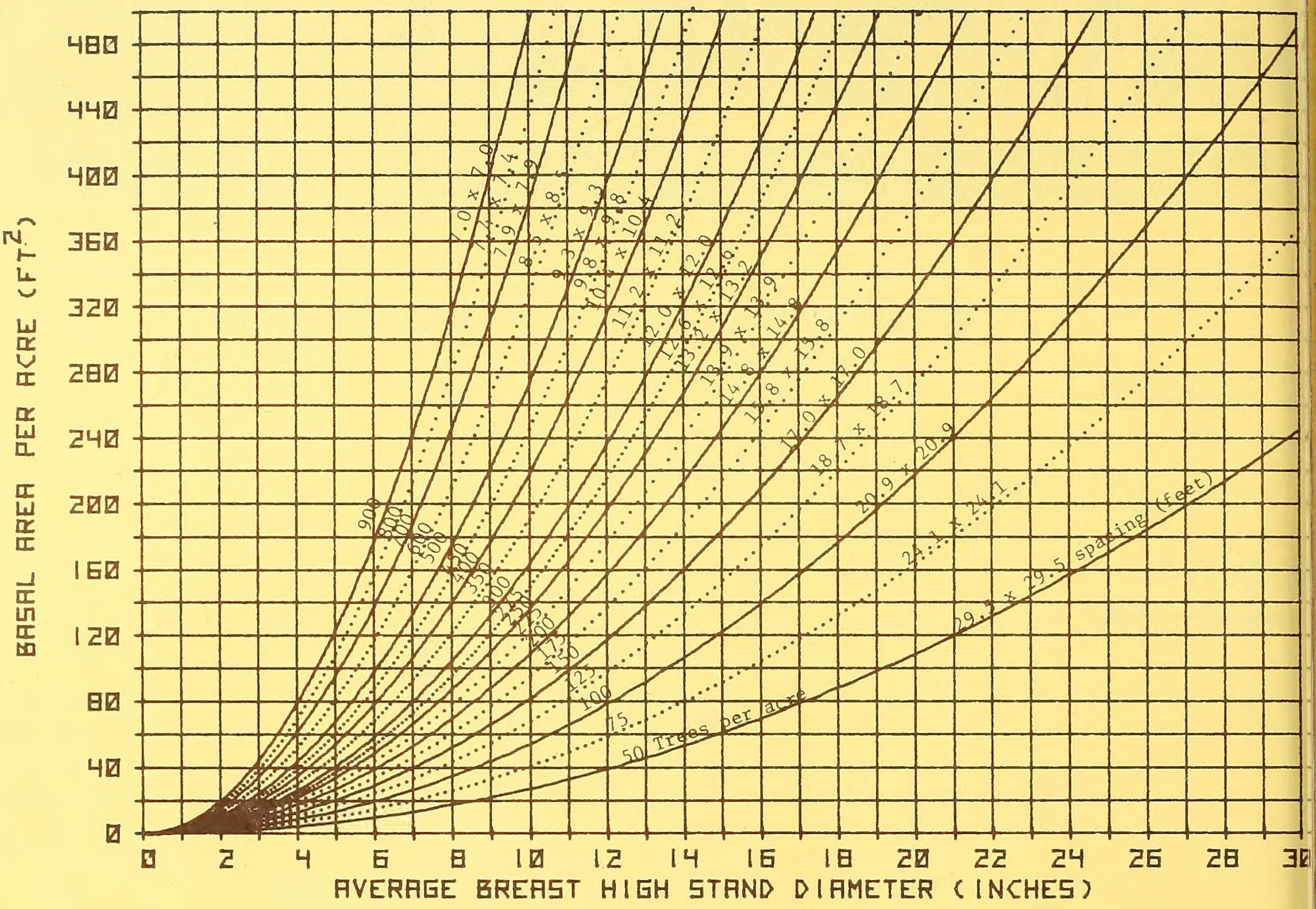

Figure 1.--Field guide for stand basal area, average d.b.h. and tree spacing relationships (English).

The graph (fig. 2) of basal area in square meters as a function of average stand diameter in centimeters and trees per hectare was developed by solving the equation

$$B = 0.00007853982 \times \bar{D}_g^2 \times TPH;$$

where,

$\bar{D}_g$ = diameter of tree of average basal area in stand (centimeters),

TPH = trees per hectare, and

B = basal area of stand (square meters).

The metric guide will help the reader who needs to interpret silvicultural and mensurational statistics expressed in the metric system.

To interpolate between curves, solve the equation for specific stand diameters and trees per acre.

Some examples of field use follow.

COMMERCIAL THINNING

A common field use is the determination of the feasibility of

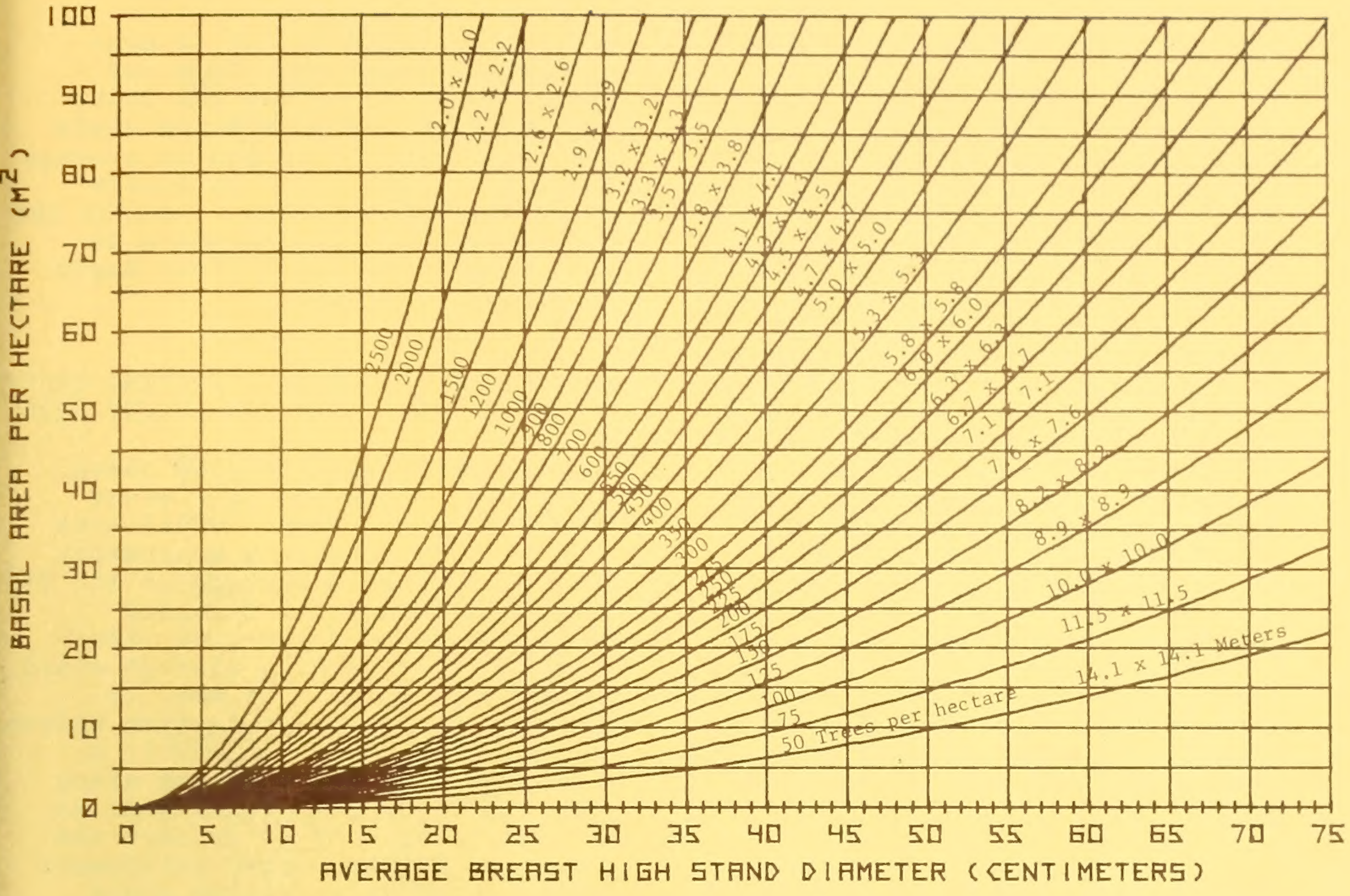

Figure 2.--Field guide for stand basal area, average d.b.h. and tree spacing relationships (Metric).

commercially thinning a young timber stand. Assume that stand diameter averages 15 inches with 150 trees per acre. With this diameter and density, basal area is slightly over 180 ft^2 (fig. 1). Trees under 10 in are not merchantable. We can then visualize that to reduce the stand to a residual basal area of 100 ft^2, 100 trees averaging 12-in d.b.h. (80-ft^2 basal area/acre) would have to be harvested. A cut tree tally in the stand might show that only 75 trees per acre (TPA) averaging 12 in could be cut without removing some trees slightly less than 10 in. From figure 1 we find that this would reduce basal area only 60 ft^2 (12-in d.b.h. and 75 TPA = 60-ft^2 basal area) indicating the need to mark additional trees in the larger size classes. After the desired cut-leave ratio is approximated using the graph in figure 1, a precise answer using the final stand tally can be calculated from the equations on the back of the field guide.

INITIAL TREE SPACING IN THINNING

Imagine a dense sapling stand to be thinned to 450 trees per acre. Also, assume that because of the probability of mountain pine beetle attack the stand cannot exceed 140 ft^2 of basal area before another commercial thinning. A horizontal line drawn across figure 1 at 140 ft^2 intersects the curved line representing 450 trees per acre at an average stand diameter of about 7.5 in. This intersect represents the average tree d.b.h. when the stand must be partially harvested. Therefore, if we leave this many trees, we assume that there will be a market for trees 8-in d.b.h. or less unless we are willing to thin from above. If a market for this size material will not exist, then we may look at the curve with fewer trees. Two hundred and fifty trees would indicate an average diameter of about 10 in when the stand contained 140 ft^2 of basal area.

INITIAL TREE SPACING IN A PLANTING PROJECT

A similar use might arise in planting a low site where we could not let the stand exceed a basal area of 120 ft^2. If 10 in is the anticipated minimum marketable size, then we should have about 225 trees just prior to commercial thinning. If we expect a 25-percent mortality rate and an additional 30 percent are slow growers or are forked or crooked, then 500 trees per acre should be planted. The 30-percent poor trees would be cut in precommercial thinning. From our graph, however, we can see that our 500 tree per acre stand could not be allowed to exceed an average diameter of about 6.5 in before precommercial thinning. Ideally the precommercial thinning would be done much sooner when trees begin to express dominance.

PREDICTING APPROXIMATE CUTTING CYCLES WITHIN A BASAL AREA MANAGEMENT BAND

Suppose we want to make three commercial thinnings in a stand before final harvest. Basal area will be held between a management band of 80 and an extreme of 140 ft^2. The first commercial pulpwood harvest reduced leave-tree basal area to 80 ft^2 and an average stand diameter of 10 in. We want to estimate the approximate time before another commercial entry will be necessary. We see from the graph that the 10-in stand will grow to an average size of 13 in when the stand reaches the upper management limit of 140 ft^2. If the yield table predicts a 3-in per decade growth at this density and size, it will take about 10 years before the next harvest is due.

Other uses of the guide will come to mind as different problems arise.

-METRIC EQUATIONS-

The following formula can be solved in the field with most hand held electronic calculators.

$$\text{NUMBER OF TREES PER HECTARE} = \frac{10{,}000}{\text{SPACING}^2\ (\text{METERS})}$$

OR

$$\text{SPACING (METERS)} = \sqrt{\frac{10{,}000}{\text{TREES PER HECTARE}}}$$

$$\text{BASAL AREA(B) (SQUARE METERS)} = .00007853932\ \Sigma D^2$$

OR

$$B = \frac{\Sigma D^2}{12{,}732.398}$$

Where ΣD^2 is the sum of the squares of the diameters expressed in centimeters, and basal area is the total for those trees measured.

$$\text{AVERAGE STAND DIAMETER (CENTIMETERS)}\ \overline{D} = \sqrt{\frac{\Sigma D^2}{N}}$$

OR

$$\overline{D} = \sqrt{\frac{B}{.00007853982\ N}}$$

Where N is the number of trees measured and B is the basal area per hectare.

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This graphic guide may be used for rough approximations of stand characteristics where at least two dimensions are known. If more refined answers are desired, the equations on the back side of the guide will be useful.

METRIC

-EQUATIONS-

The following formula can be solved in the field with most hand held electronic calculators.

$$\text{NUMBER OF TREES PER ACRE} = \frac{43560}{\text{SPACING}^2\ (\text{FEET})}$$

OR

$$\text{SPACING (FEET)} = \sqrt{\frac{43560}{\text{TREES PER ACRE}}}$$

$$\text{BASAL AREA(B) (SQUARE FEET)} = .005454154\ \Sigma D^2$$

OR

$$B = \frac{\Sigma D^2}{183.3465}$$

Where ΣD^2 is the sum of the squares of the diameters expressed in inches, and basal area is the total for those trees measured.

$$\text{AVERAGE STAND DIAMETER } (\overline{D}) \text{ (INCHES)} = \sqrt{\frac{\Sigma D^2}{N}}$$

OR

$$\overline{D} = \sqrt{\frac{B}{.005454154\ N}}$$

Where N is the number of trees measured and B is the basal area per acre.

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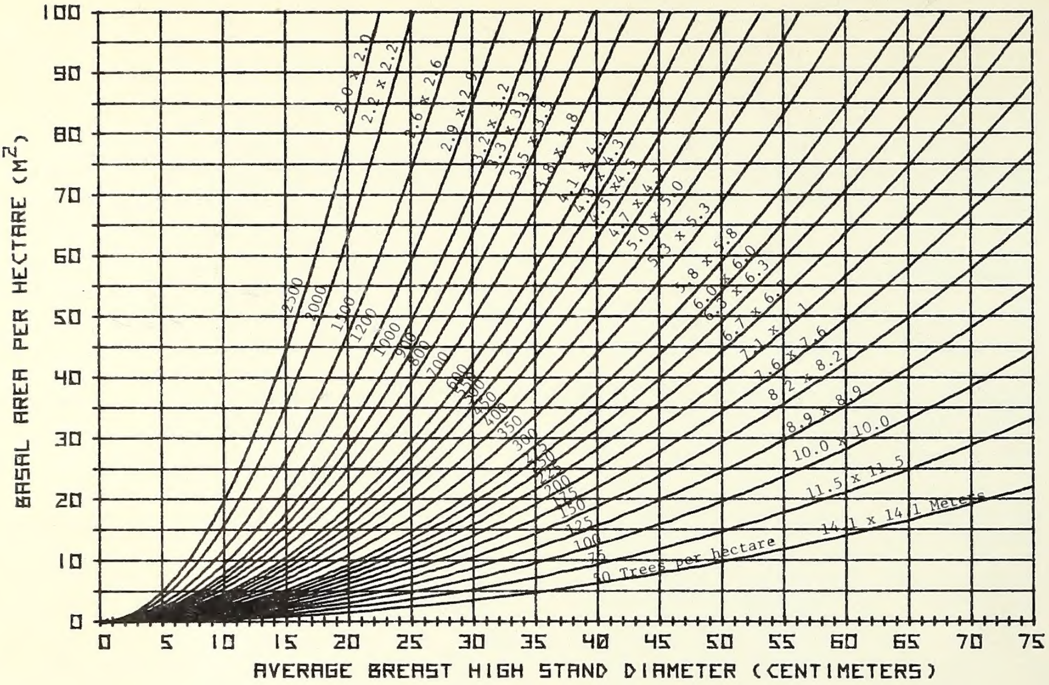

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